The Helicopter Monitoring Report

a Report of the New York Bight Water Quality

2002

From the Harbor... *to the ocean...*

to the back bays... *EPA's Coastal Crusader monitoring the water.*

United States Environmental Protection Agency, Region 2
Division of Environmental Science and Assessment
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NEW YORK BIGHT WATER QUALITY

2002

"The Bight Report"

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Abstract

The Division of Environmental Science and Assessment of the U.S. Environmental Protection Agency, Region 2, has prepared this report to disseminate environmental data collected for the New York Bight. From May 23, 2002 through September 6, 2002, water quality monitoring and surveillance activities were carried out using a helicopter. The monitoring program is comprised of three separate networks; the beach station network, the perpendicular station network, and the floatable surveillance network.

Results were as follows:

A total of 709 samples were collected and analyzed for fecal coliform and enterococcus bacteria from stations along the Long Island and New Jersey coastal beach station network. Low seasonal geometric means were observed at all stations for 2002.

The dissolved oxygen semi-monthly averages for the New York Bight and New Jersey coast perpendicular station network followed a typical dissolved oxygen sag curve. The lowest semi-monthly dissolved oxygen average, 4.0 mg/l, occurred in late August, followed by a steady increase to 6.5 mg/l in early September.

There were no ocean beach closures in New Jersey due to floatable debris in 2002. Only one beach closure incident occurred due to floatable debris along Long Island coastal waters.

Based on the data collected, the New York Bight Apex, and the New Jersey and Long Island coastal waters had good water quality in 2002.

INTRODUCTION

The Division of Environmental Science and Assessment of the U.S. Environmental Protection Agency (EPA), Region 2, has prepared this report to disseminate environmental data for the New York Bight. Specifically, data coverage includes the New York Bight Apex, the New York/New Jersey Harbor Complex, and the coastal shorelines of New York (NY) and New Jersey (NJ).

This report is the twenty-fourth in a series and reflects data collected from May 23 to September 6, 2002.

The New York Bight Water Quality Monitoring Program (The Helicopter Monitoring Program) is EPA's response to its mandated responsibilities as defined under the Marine Protection, Research and Sanctuaries Act of 1972, the Water Pollution Control Act Amendments of 1972 and 1977, and the Water Quality Act of 1987. This program was initiated in 1974 and incorporated the use of a helicopter in 1977.

Presently, a modified Twin Star helicopter is used (pictured below).

SAMPLING AND SURVEILLANCE

Purpose, Procedures and Locations

Water quality monitoring and surveillance activities were carried out using a helicopter. While the helicopter hovered over the surface, sampling was accomplished by lowering a one liter Kemmerer sampler into the water.

Details of the analytical and sampling procedures can be found in the Quality Assurance Project Plan for the New York Bight Summer Monitoring Program (available upon request). The raw data can be found in EPA's computerized database for STOrage and RETrieval (STORET).

The monitoring program is composed of three separate networks.

The beach station network

is sampled to gather bacteriological water quality information on swimmability for comprehensive public health protection.

Samples are collected once a week at twenty-six Long Island coastal (LIC) stations extending from the western tip of Rockaway Point eastward to Shinnecock Inlet (Figure 1) and at forty-four New Jersey coastal (JC) stations from Sandy Hook to Cape May (Figure 2). All samples are collected just offshore in the surf zone at one meter depth.

Analyses for fecal coliform and enterococcus bacteria densities are conducted at the EPA Region 2 Edison Laboratory.

The perpendicular station network

is sampled to monitor for bottom dissolved oxygen concentrations and temperature. These parameters are used for early detection of anoxic conditions and trend analysis.

Nine New Jersey coast (JC) perpendicular transects extend east one nautical mile to nine nautical miles off the coast between Long Branch and Hereford Inlet, and one New York Bight (NYB) Apex perpendicular transect extends east from the southern end of Sandy Hook (Figure 3).

New Jersey coast perpendicular stations were sampled at 1, 3, 5, 7, and 9 nautical miles offshore. Historical New York Bight Apex stations, NYB 20, 21, 22, 23 and 24, were sampled approximately 2, 4, 6, 7, and 8 nautical miles off the southern end of Sandy Hook.

Samples are collected one meter above the ocean floor, eight to ten times during the critical summer period. The dissolved oxygen analyses are conducted at the EPA Region 2 Edison Laboratory.

The floatable surveillance network

encompasses overflights of the New York/New Jersey Harbor Complex six days a week during the summer months. This surveillance is in response to the Short Term Action Plan for Addressing Floatable Debris, (USEPA 1989) developed by the Interagency Floatable Task Force. The plan was initiated after extensive garbage washups and beach closures occurred in 1987 and 1988. The plan's objectives are to improve water quality, protect the marine environment, and prevent the occurrence of beach closures due to floatables debris. This is accomplished by sighting slicks and determining the most efficient coordinated cleanup effort possible. Approximate size or dimension, contents, relative density, location, possible sources and time of sighting of significant floatable debris are recorded. The information is reported to a central communication response network, specifically established to coordinate cleanup efforts. Cleanup efforts are conducted via skimmer boats or vessels by the Corps of Engineers or the New York City Department of Environmental Protection.

For purposes of this report, the New York/New Jersey Harbor Complex is defined as the following five waterbodies: 1) the Arthur Kill; 2) Newark Bay, as far north as the New Jersey Turnpike Bridge; 3) the Kill Van Kull; 4) the Upper New York Harbor, including the lower portions of the Hudson River and the East River as far north as Central Park, New York; and 5) the Lower New York Harbor including Gravesend Bay, and the shoreline of Coney Island as far east as the Marine Parkway Bridge (Figure 4).

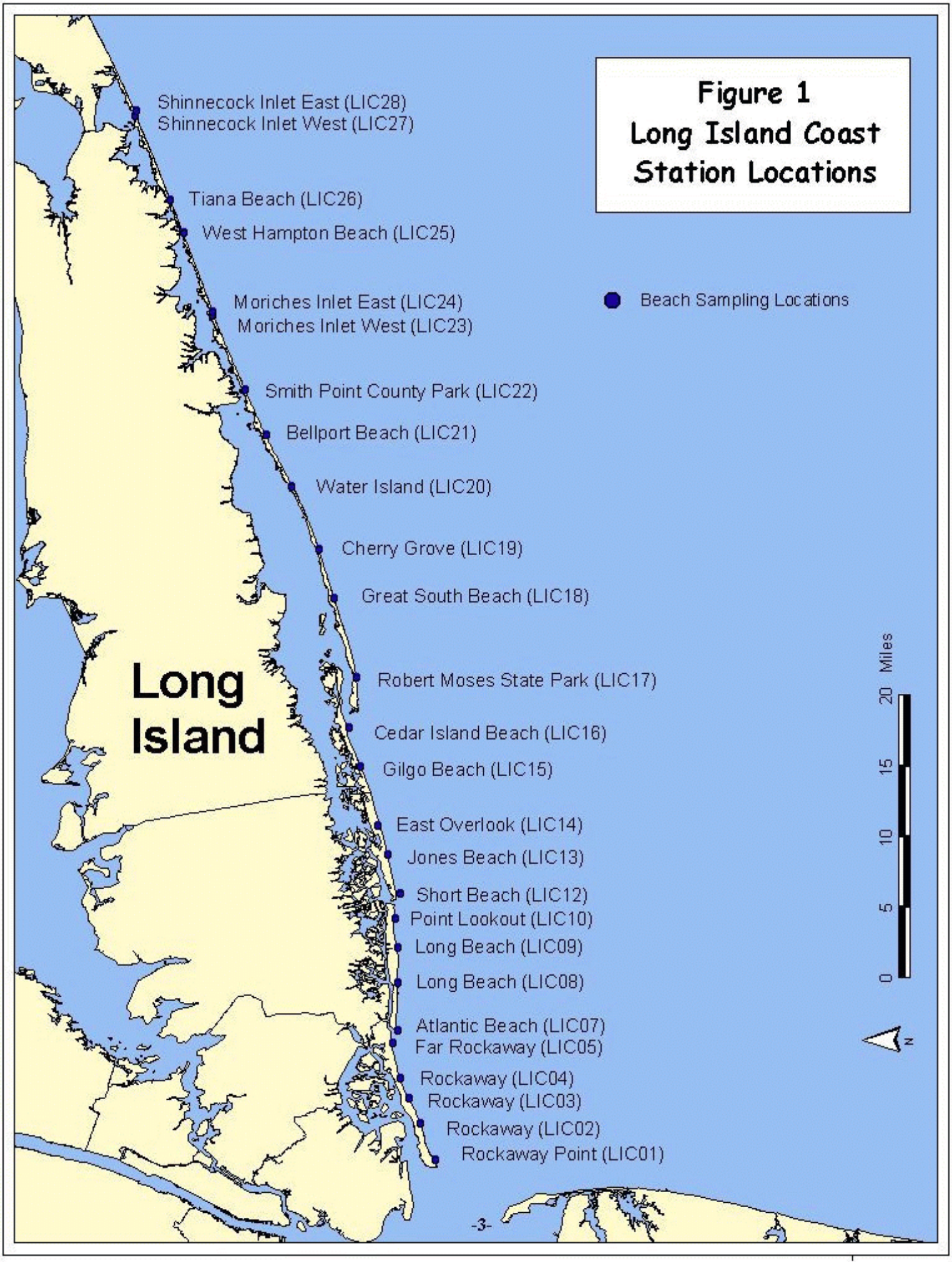


Figure 1
Long Island Coast
Station Locations
Beach Sampling Locations
Shinnecock Inlet East (LIC28)
Shinnecock Inlet West (LIC27)
Tiana Beach (LIC26)
West Hampton Beach (LIC25)
Moriches Inlet East (LIC24)
Moriches Inlet West (LIC23)
Smith Point County Park (LIC22)
Bellport Beach (LIC21)
Water Island (LIC20)
Cherry Grove (LIC19)
Great South Beach (LIC18)
Long Island
Robert Moses State Park (LIC17)
Cedar Island Beach (LIC16)
Gilgo Beach (LIC15)
East Overlook (LIC14)
Jones Beach (LIC13)
Short Beach (LIC12)
Point Lookout (LIC10)
Long Beach (LIC09)
Long Beach (LIC08)
Atlantic Beach (LIC07)
Far Rockaway (LIC05)
Rockaway (LIC04)
Rockaway (LIC03)
Rockaway (LIC02)
Rockaway Point (LIC01)
0 5 10 15 20 Miles
N


Figure 2
New Jersey Coast Station Locations
New Jersey
Sandy Hook (JC01A)
Sandy Hook (JC03)
Sandy Hook (JC05)
Sea Bright (JC08)
Monmouth Beach (JC11)
Long Branch (JC13)
Long Branch (JC14)
Asbury Park (JC21)
Bradley Beach (JC24)
Shark River Inlet (JC26)
Belmar (JC27)
Spring Lake (JC30)
Spring Lake (JC33)
North Manasquan Inlet (JC35)
South Manasquan Inlet (JC37)
Bay Head (JC41)
Mantoloking (JC44)
Silver Beach (JC47A)
Lavallette (JC49)
Seaside Heights (JC53)
Island Beach State Park (JC55)
Island Beach State Park (JC57)
Island Beach State Park (JC59)
Barnegat (JC61)
Harvey Cedars (JC63)
Ship Bottom (JC65)
Beach Haven Terrace (JC67)
Beach Haven Heights (JC69)
Brigantine (JC73)
Absecon Inlet (JC74)
Atlantic City (JC75)
Ventnor City (JC77)
Longport (JC79)
Ocean City (JC81)
Peck Beach (JC83)
Strathmere (JC85)
Sea Isle City (JC87)
Avalon (JC89)
Hereford Inlet (JC92)
Wildwood (JC93)
Two Mile Beach (JC95)
Cape May Inlet (JC96)
Cape May (JC97)
Cape May Point (JC99)
Beach Sampling Locations
0 10 20 Miles
N

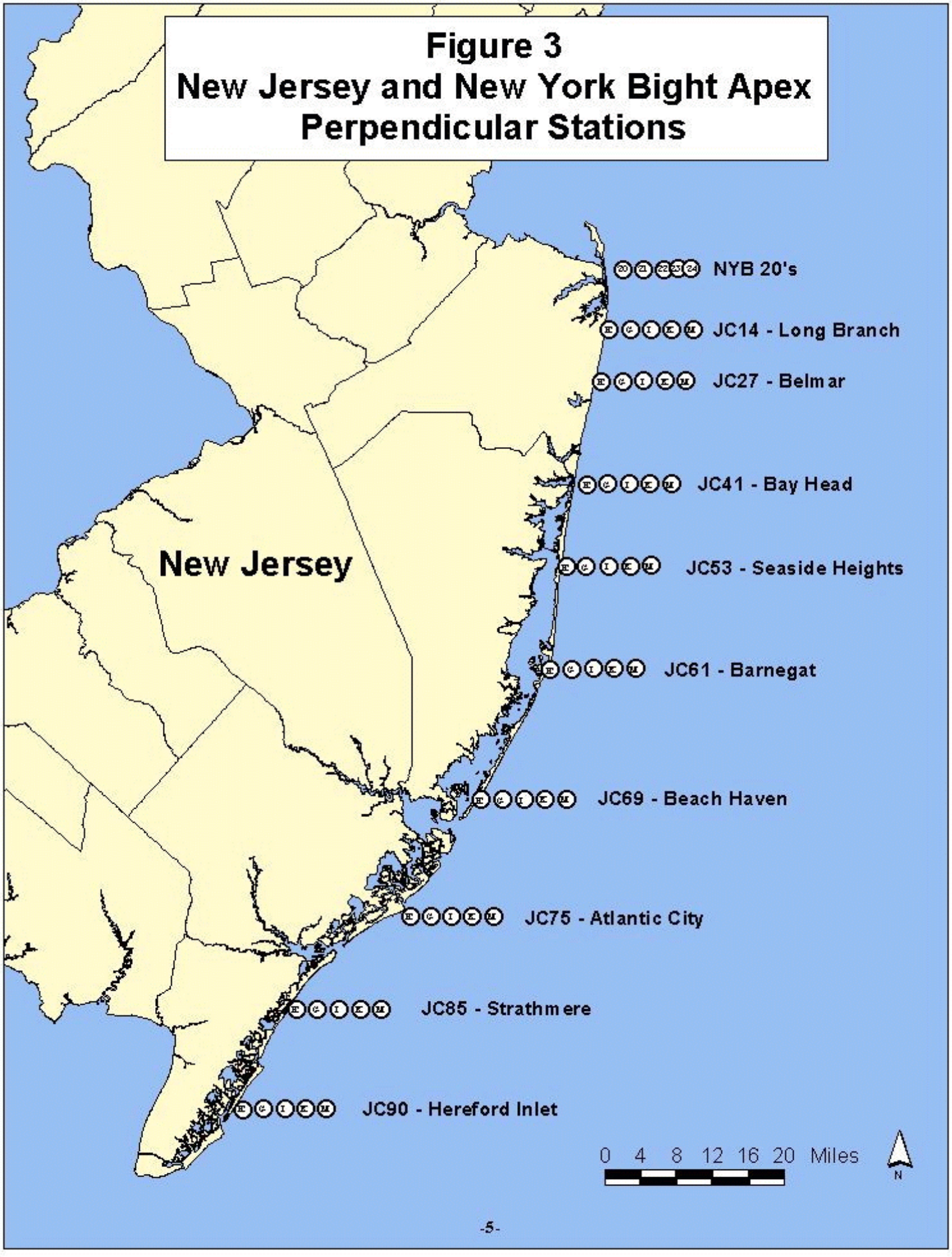


Figure 3
New Jersey and New York Bight Apex
Perpendicular Stations
NYB 20's
JC14 - Long Branch
JC27 - Belmar
JC41 - Bay Head
New Jersey
JC53 - Seaside Heights
JC61 - Barnegat
JC69 - Beach Haven
JC75 - Atlantic City
JC85 - Strathmere
JC90 - Hereford Inlet
0 4 8 12 16 20 Miles
N

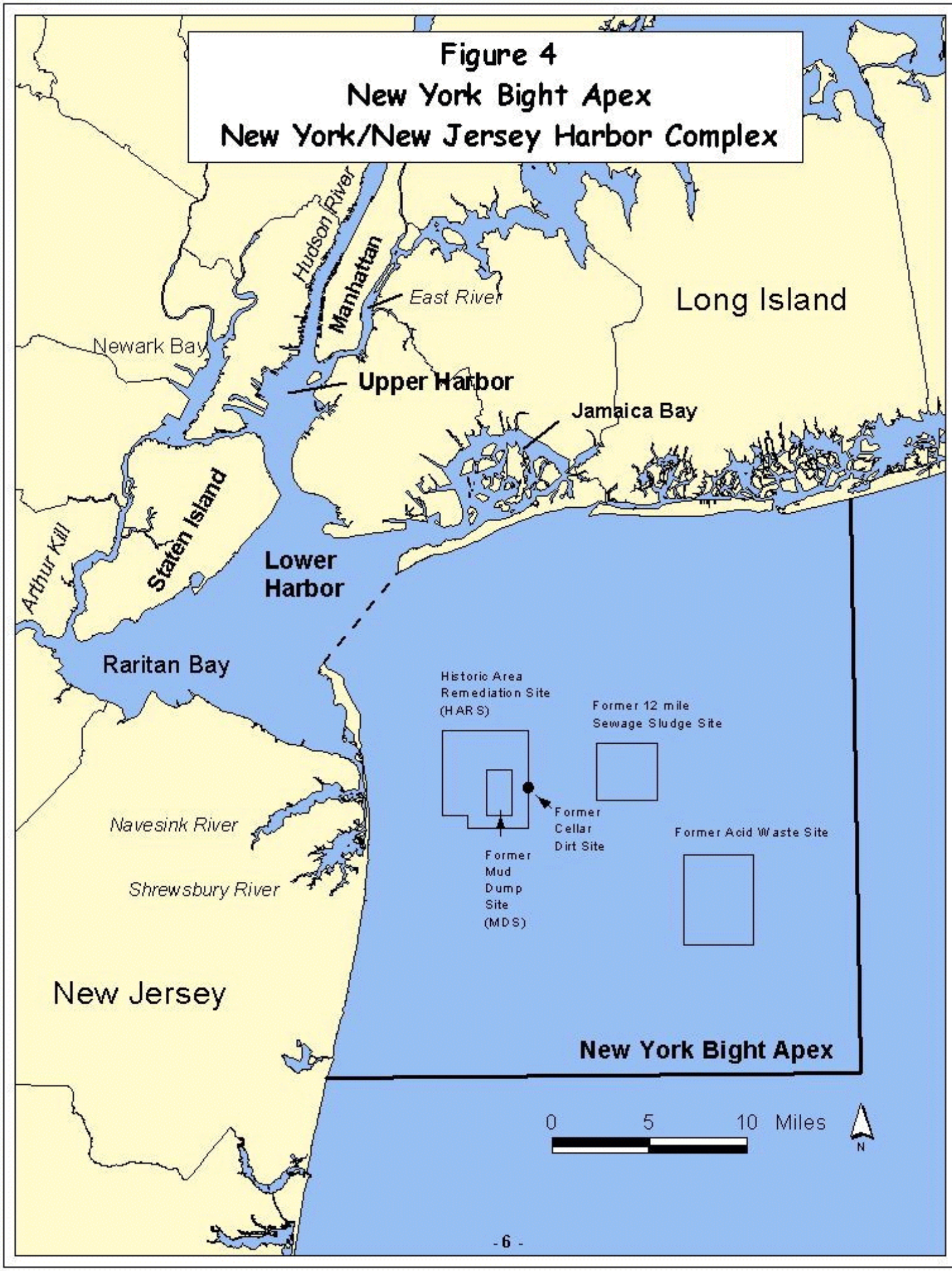


Figure 4
New York Bight Apex
New York/New Jersey Harbor Complex
Hudson River
Manhattan
East River
Long Island
Newark Bay
Upper Harbor
Jamaica Bay
Staten Island
Arthur Kill
Lower Harbor
Raritan Bay
Historic Area Remediation Site (HARS)
Former 12 mile Sewage Sludge Site
Former Cellar Dirt Site
Former Acid Waste Site
Former Mud Dump Site (MDS)
Navesink River
Shrewsbury River
New Jersey
New York Bight Apex
0 5 10 Miles
N

THE BEACH STATION NETWORK

Guideline, Criteria and Standards

By determining the bacteriological water quality, one can estimate potential health risks associated with ocean recreational activities. Epidemiological studies have attempted to assess the incidence of illness associated with bathing in water containing fecal contamination. Evidence exists that there is a relationship between bacterial water quality and transmission of certain infectious diseases (Cabelli, 1979).

It is common practice to use an indicator organism to detect fecal contamination because of the ease of isolating and quantitating certain microorganisms on membrane filters. When many indicator organisms are present, the likelihood of pathogens being found is far greater. EPA has issued guidelines for the following indicator organisms:

EPA Guidelines/Criteria

Fecal Coliform

A fecal coliform bacterial guideline for primary contact recreational waters was recommended by the EPA in 1976, and subsequently adopted by most of the States. The EPA guideline states that fecal coliforms should be used as the indicator to evaluate the suitability for swimming in recreational waters, and recommends that fecal coliforms, as determined by MPN or MF procedure and based on a minimum of not less than five samples taken over not more than a 30-day period, shall not exceed a log mean of 200 fecal coliforms/100 ml, nor shall more than 10% of the total samples during any 30-day period exceed 400 fecal coliforms/100 ml (USEPA, 1976).

Enterococci

In 1986, EPA issued a criteria guidance document recommending enterococci and *Escherichia coli* for inclusion into state water quality standards for the protection of primary contact recreational uses in lieu of fecal coliforms. The EPA (1986) recommended criterion for enterococci for marine water is a single sample maximum of 104 enterococci/100 ml, or a minimum of not less than five samples taken over not more than a 30-day period, shall not exceed a log mean of 35/100 ml (USEPA 1986). The Beaches Environmental Assessment, and Coastal Health Act of 2000, requires coastal States to adopt the 1986 criteria by April 2004.

NJDEP Surface Water Quality Standards

New Jersey has adopted the standard of 200 fecal coliforms/100 ml. Local officials may close a beach on the basis of a single sample. Local discretion is allowed up to the point of two consecutive exceedances, when closure is required by New Jersey State law (NJDEP, 1998).

NYSDEC Surface Water Quality Standards

New York State, for its primary contact recreational coastal waters, allows the local permit issuing official to choose one of two standards as follows: 1) a thirty day, five-sample log average of 200 fecal coliforms/100 ml, or 2) a thirty day, five sample log average of 2400 total coliforms/100 ml (NYSDEC, 1999).

Any exceedances of these criteria are immediately reported to the proper state and local authorities.

BACTERIOLOGICAL RESULTS

Each of the 26 Long Island coastal stations and the 44 New Jersey coastal stations was sampled five to thirteen times in 2002. A total of 337 samples was collected along the Long Island stations, and 372 samples were collected at the New Jersey stations. Samples were collected approximately once per week from late May to early September, and analyzed for fecal coliform and enterococcus densities.

Individual Fecal Coliform Counts

Only one individual fecal coliform count for the Long Island coastal stations exceeded the federal guideline of 200 fecal coliforms per 100 ml. The exceedance, 820 fecal coliforms per 100 ml, occurred at Rockaway Point (LIC01), on August 27, 2002.

All individual fecal coliform counts for the New Jersey coastal stations were below the federal guideline of 200 fecal coliforms per 100 ml. The highest value for the year, 144 fecal coliforms per 100 ml, occurred at Bradley Beach (JC24), on August 28, 2002.

Individual Enterococcus Counts

All individual enterococcus counts for the Long Island coastal stations were below the federal single sample maximum of 104 enterococci per 100 ml. The highest value for the year, 68 enterococci per100 ml, occurred at Smith Point County Park, (LIC22), on July 30, 2002.

Two enterococcus counts exceeded the federal single sample maximum of 104 enterococci per ml at the New Jersey coastal stations. The exceedances, 115 and 240 enterococci per 100 ml, occurred at Long Branch (JC14) on July 24 and Mantoloking (JC44) on August 28, respectively.

Bacteriological Trends

Seasonal geometric means were calculated for each coastal station. Below is a ten year comparison of the highest individual station seasonal geometric mean density per year. All seasonal geometric means were substantially below fecal coliform and enterococcus guidelines.

The summer of 2000 had the highest individual station (Rockaway Point) fecal coliform geometric mean, and 1998 had the highest enterococcus geometric mean (Asbury Park) for New Jersey and Long Island stations.

Highest Seasonal Geometric Mean Densities (per 100 ml)
1993 - 2002

Year	New Jersey Station	Geometric Mean	Long Island Station	Geometric Mean
Fecal Coliform Densities				
1993	JC96	5.13	LIC10	1.99
1994	JC53	3.77	LIC04	2.12
1995	JC75	2.86	LIC16	2.89
1996	JC53	7.34	LIC03	3.45
1997	JC26	4.51	LIC10	3.83
1998	JC96	9.09	LIC04	4.48
1999	JC92	3.85	LIC10	2.87
2000	JC26	4.98	LIC01	9.46
2001	JC37	3.49	LIC01	6.64
2002	JC26	4.44	LIC01	3.34
Enterococcus Densities*				
1993	JC96	2.70	LIC17	1.18
1994	JC96	2.02	LIC04	1.38
1995	JC96	2.64	LIC10	1.87
1996	JC96	3.67	LIC22	2.38
1997	JC27	2.76	LIC10	1.81
1998	JC21	11.25	LIC01	4.12
1999	JC96	4.15	LIC04,21	1.41
2000	JC75	3.90	LIC01	2.20
2001	JC21	4.12	LIC28	2.90
2002	JC14	3.84	LIC05	1.83

*From 1992 - 1997, a 48 hour enterococcus test method was used.
From 1998 - 2002, the 24 hour EPA 1600 enterococcus test method was used.

The Perpendicular Station Network

Dissolved Oxygen Guidelines

Dissolved oxygen levels necessary for survival and/or reproduction vary among biological species. Sufficient data have not been accumulated to assign definitive limits or lower levels of tolerance for each species at various growth stages. As in previous reports, the following guidelines will be used (USEPA 1977):

Dissolved Oxygen Guidelines

5 mg/l - healthy
4 - 5 mg/l - borderline to healthy
3 - 4 mg/l - stressful if prolonged
2 - 3 mg/l - lethal if prolonged
< 2 mg/l - lethal in a relatively short time

These guidelines are consistent with EPA's *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras, Nov. 2000* (USEPA, 2000).

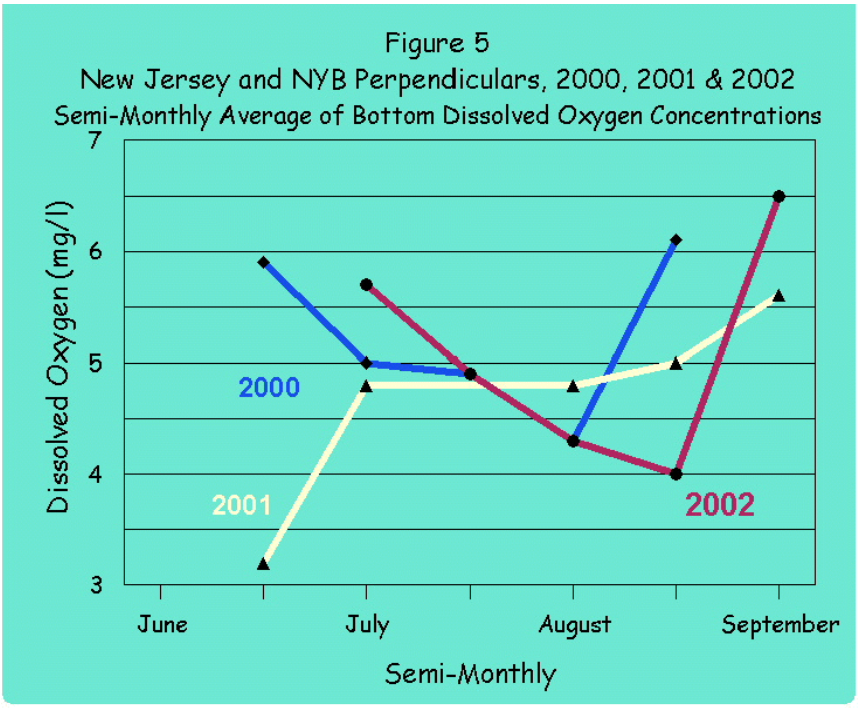
Discussion and Results

In 2002, bottom water samples were collected and analyzed for dissolved oxygen from early June to early September. Each station was visited five to seven times for a total of 301 samples at the New York Bight (NYB20, 21, 22, 23, 24) and New Jersey coast perpendicular stations (JC14, 27, 41, 53, 61, 69, 75, 85, 90).

For comparison, three years of bottom dissolved oxygen results are presented in Table 1. In all three years, the majority of the dissolved oxygen results was greater than the borderline to healthy guideline of 4 mg/l. There were no individual dissolved oxygen concentrations below 2 mg/l in 2001. In 2000, only one value, or 0.3%, was less than 2 mg/l. The highest percentage, 5.3%, of values below 2 mg/l occurred in 2002.

Table 1

Bottom Dissolved Oxygen Results	2000	2001	2002
Total Number of Samples Collected	350	309	301
% greater than 5 mg/l	54.9	49.2	49.2
% between 4-5	20.6	19.1	19.9
% between 3-4	15.1	18.1	17.6
% between 2-3	9.1	13.6	8.0
% less than 2 mg/l	0.3	0	5.3



Semi-Monthly Averages

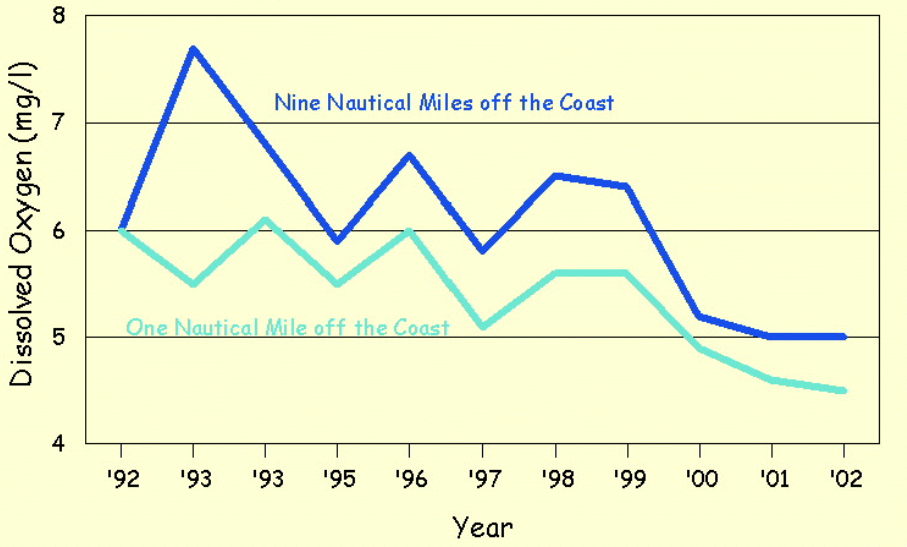
The 2000 and 2002 semi-monthly averages of bottom dissolved oxygen concentrations for the New York Bight and New Jersey coast perpendiculars follow a typical dissolved oxygen sag curve with lows occurring in early to late August (Figure 5). In 2001, a low semi-monthly average dissolved oxygen concentration occurred in late June, with a steady increase through early September. The lowest dissolved oxygen semi-monthly average over the three-year period, 3.2 mg/l, occurred in late June of 2001.

Dissolved Oxygen Trends

One Mile vs. Nine Miles

With the exception of 1992, average dissolved oxygen values are 0.3 to 2.2 mg/l higher nine miles off the coast than one mile off the coast, from 1992 through 2002 (Figure 6). The lower values at the one mile offshore stations can be explained by the oxygen demand created by the influences of river discharges, treatment plant effluents, stormwater runoff, and/or the plume from the Hudson-Raritan River Estuary system.

Figure 6
New Jersey Perpendiculars, 1992 - 2002
Average Dissolved Oxygen Concentrations: One and Nine Nautical Miles off the Coast



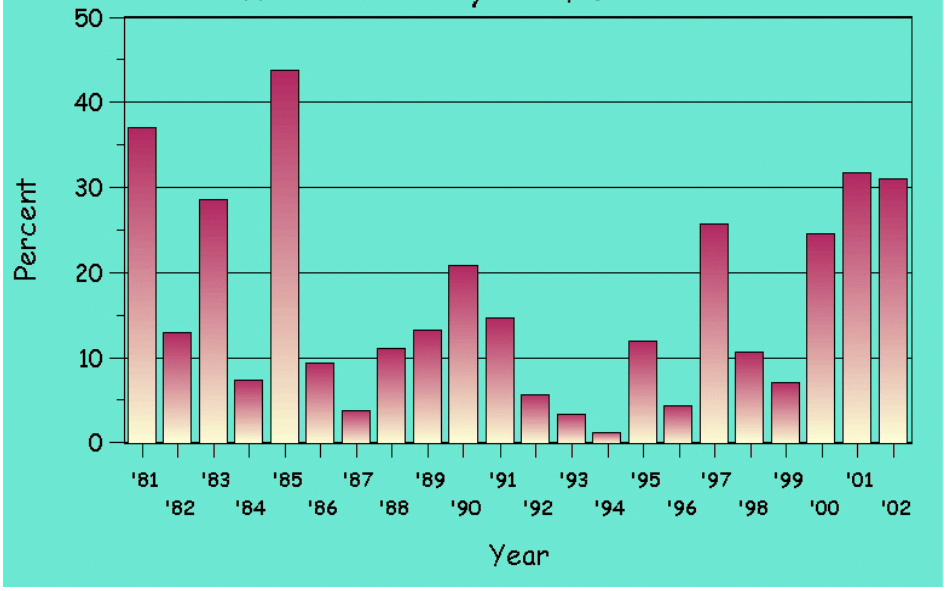
Values Below 4 mg/l

The percent of New Jersey bottom dissolved oxygen values below 4 mg/l, ranged from a low of 1.2 percent to a high of 43.8 percent, during the sampling period of 1981 - 2002 (Figure 7).

Depressed levels fluctuated greatly, year to year, from 1981 through 1986. From 1986 to 1996, fluctuation from year to year was less severe. The highest percentage of hypoxic samples occurred in 1985.

The depressed dissolved oxygen levels in 1985 were attributed to the decomposition of the organisms responsible for the numerous algal blooms that occurred, the lack of meteorological events favoring reaeration, such as substantial winds and storm activity, and the presence of a strong thermocline. The below average dissolved oxygen levels in 1997, 2000, 2001 and 2002 were not as widespread or persistent as those encountered in 1985.

Figure 7
Dissolved Oxygen Trends - Percent of Bottom Values Below 4 mg/l
Off the New Jersey Coast, 1981 - 2002



Water Quality

During the summer 2002, few coastal algal blooms were observed, strong winds prevailed, water temperature remained low, there were numerous storms promoting reaeration, and no fish kills or adverse effects were reported.

A trend of decreasing dissolved oxygen values has been observed for the past three years. Further investigation of low dissolved oxygen off the coast of New Jersey is being conducted by NJDEP.

THE FLOATABLE SURVEILLANCE NETWORK

Observations and Discussion

Floatable surveillance was conducted Monday through Saturday, weather permitting, from May 23, 2002 through August 31, 2002.

Guidelines for Reportable Floatable Debris

For cleanup purposes, the Short Term Action Plan defined a "slick" as an aggregation of floating debris of indefinite width and a minimum length of approximately 400 meters (USEPA, 1989). Using this as a guideline, all slicks have been divided into three categories (from largest to smallest):

Size Category For Floatable Debris/Slicks

Major: any slick greater than 1600 meters in length
Heavy: 800 meters to 1600 meters
Moderate: 400 meters to 800 meters

All floatable observations have been placed in one of the three categories according to the slick's estimated dimensions, relative density and other recorded observations. The categories of slicks are somewhat subjective. Any slick just short of the length requirement that has a relatively heavy density or extensive width can be moved up a category; as any slick with a relative light density or broken pattern can be moved down a category.

2002 Floatable Observations

A total of twelve slicks was observed in 2002 (Table 2). Newark Bay had the most slicks observed, five, and the Kill Van Kull with zero slicks observed, had the least.

Table 2

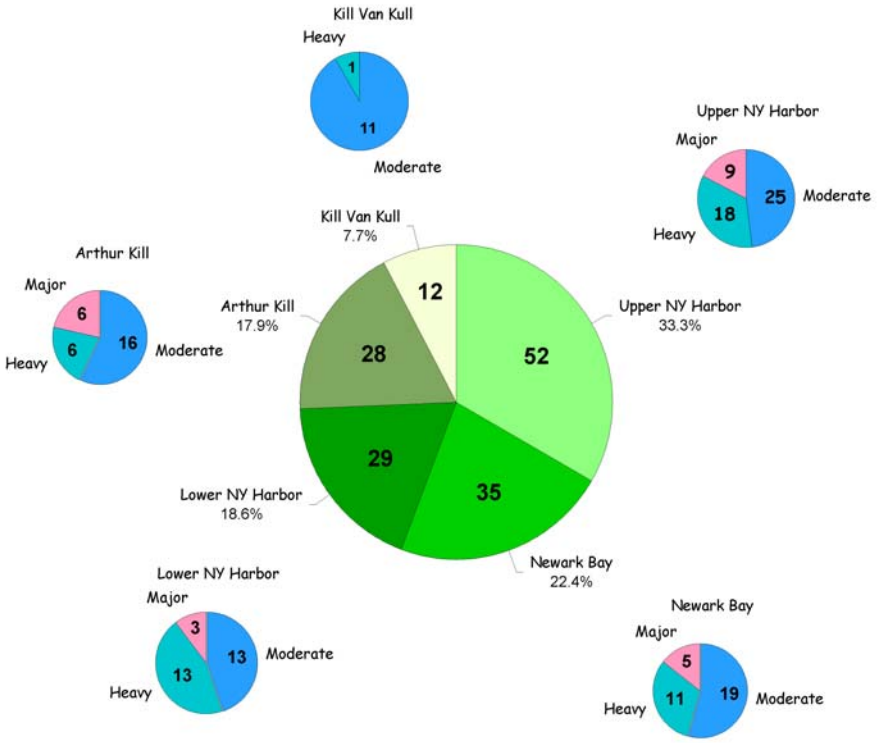
2002 Floatable Observations

	Moderate	Heavy	Major
Newark Bay	2	2	1
Lower NY Harbor	1	2	1
Upper NY Harbor	1	1	0
Arthur Kill	0	1	0
Kill Van Kull	0	0	0

Compilation

A total of 156 slicks was observed over a nine-year period, from 1994 through 2002 (Pie 1). With the exception of the Kill Van Kull, the reportable slicks observed per size category are similarly distributed at each location.

Pie 1: Nine Year Compilation of Total Observed Floatables by Location, Subdivided per Size Category, 1994 through 2002



FLOATABLE TRENDS

From late May to early September 1989 - 2002, the NY/NJ Harbor Complex was surveyed for floatables, six days a week, weather permitting. For comparison, data from the last nine years will be presented.

Over the nine-year period, a total of 156 slicks was observed (Figure 8). The sighting of slicks was variable from year to year with the most number of slicks, 46 slicks, reported in 1995. The least number of slick sightings, six slicks, was reported in 1998.

Figure 8
Trends of Floatable Observations in the NY/NJ Harbor Complex
late May - early September, 1994 - 2002

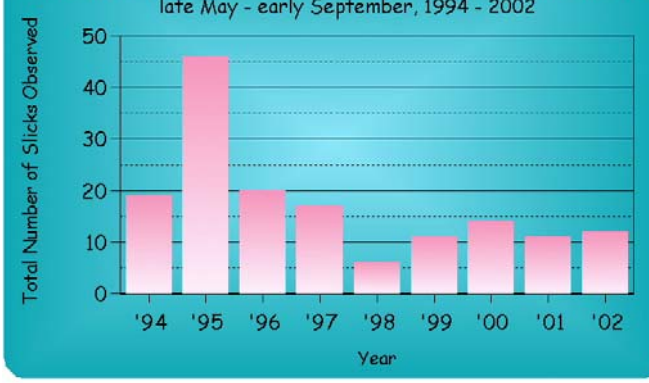
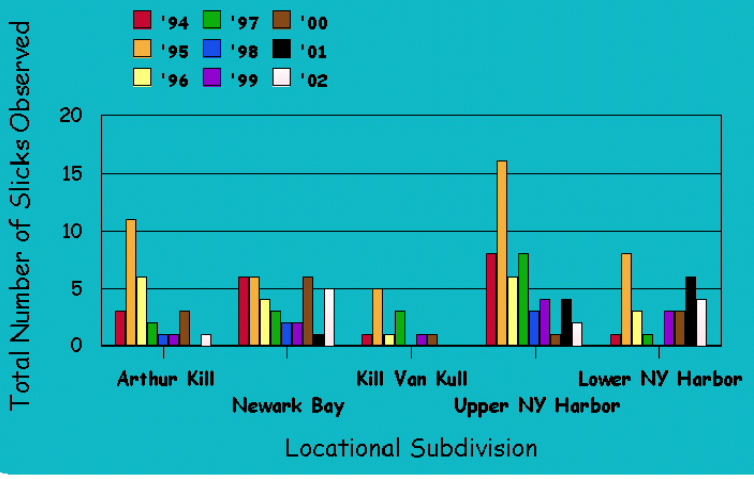


Figure 9
Trends of Floatable Observations by Locational Subdivision
NY/ NJ Harbor Complex, late May - early September, 1994 - 2002



Locational Subdivision

The Upper New York Harbor had the greatest number of slicks, 52, observed in the nine-year period. The Kill Van Kull, with 12 slicks, had the least number of slicks observed (Figure 9).

Size Category

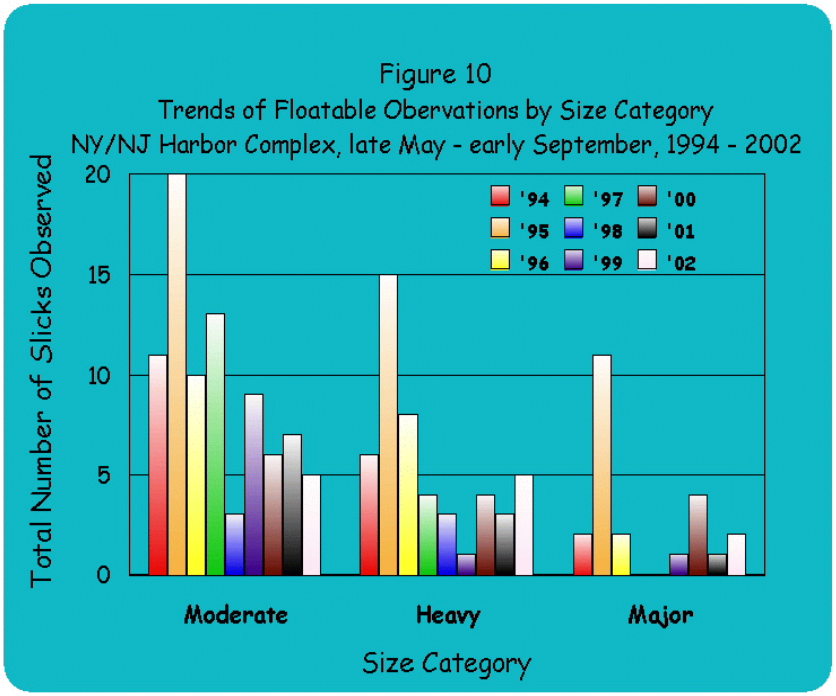
For the nine-year period, the majority of slicks observed, 53.8 percent, were in the moderate category, 31.4 percent were in the heavy category, and 14.7 percent were in the major category (Figure 10). A downward trend over time can be seen in all size categories.

Cleanup

The inter-agency monitoring and cleanup program, the initiation of beach and litter cleanup activities, such as the Clean Streets/Clean Beaches campaign, and Operations Clean Shores have contributed to a decrease in beach closures due to floatable debris, and a significant decrease in the number of slicks observed, as compared to the extensive washups in 1987 and 1988. More information on cleanup activities can be found in the *Floatable Action Plan Assessment Report 2002* (USEPA, 2002a).

In 2002, there were no New Jersey coastal beach closures due to floatable debris. Only one beach closure incident occurred in Long Island. Due to an unknown substance washing ashore, all 47 Suffolk County beaches were closed on June 12 and reopened on June 13.

Figure 10
Trends of Floatable Obervations by Size Category
NY/NJ Harbor Complex, late May - early September, 1994 - 2002



PROMOTING PARTNERSHIPS

The Helicopter Monitoring Program afforded EPA the unique opportunity to promote partnerships by assisting other federal and state agencies in the real time collection of water quality data. With a little extra coordination, EPA assisted other agencies in collecting data to complement or maintain objectives for the following national/state programs:

New Jersey Shellfish

During the data collection for the New Jersey beach station sampling network, additional samples were collected for phytoplankton analyses along the New Jersey coast, and in Raritan/Sandy Hook Bay, Barnegat Bay, Great Egg Harbor and Delaware Bay. Phytoplankton identification, quantification and chlorophyll *a* enumerations were completed by the New Jersey Department of Environmental Protection's (NJDEP) Aquatic Biomonitoring Laboratory of the Bureau of Water Monitoring. This sampling provides early warning of noxious algal blooms and complements NJDEP's commitment to the National Shellfish Sanitation Program.

Subsets of the phytoplankton samples collected in Barnegat Bay were provided to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service for the identification of the brown tide organism, *A. anophagefferens,* in 1999 and 2000. In 2001 and 2002, NJDEP arranged for the identification of *A. anophagefferens*.

Long Island Shellfish

During the data collection for the Long Island beach station sampling network, additional samples were collected at each station for the New York State Department of Environmental Conservation (NYSDEC). The NYSDEC's Division of Fish and Wildlife and Marine Resources Bureau of Marine Resources analyzed the samples for total and fecal coliforms. These samples help fulfill NYSDEC's commitment to the National Shellfish Sanitation Program.

New Jersey Nutrients

As part of EPA's Performance Partnership Agreement with NJDEP, surface water samples were collected three to four times each year at 41 stations from Sandy Hook to Cape May, and in Delaware Bay. The samples were analyzed by NJDEP for chlorophyll, salinity, nitrate, nitrite, ortho-phosphate, ammonia, total nitrogen, and total suspended solids. Temperature was recorded in the field and dissolved oxygen analyses were conducted by the EPA Edison Laboratory. The 41 stations are part of NJDEP's 200 Station Network.

Delaware Estuary Nutrients

At the request of the Delaware River Basin Commission (DRBC), surface water samples were collected at low slack tide at four sites along the Delaware River three times during the summer. This sampling started in 2001 and continued in 2002. All samples were analyzed by a contract laboratory for bacteria, algae, metals, dissolved oxygen and organic carbon. This sampling enhanced DRBC's longstanding water quality sampling program in the Delaware Estuary.

DEFGHLOPSY

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